COMPARISON OF SURFACE WATER pCO_2 AND SST DATA DURING AN ENCOUNTER OF RVIB PALMER AND RV GOULD ON MARCH 13, 2009

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1. SUMMARY AND CONCLUSION:

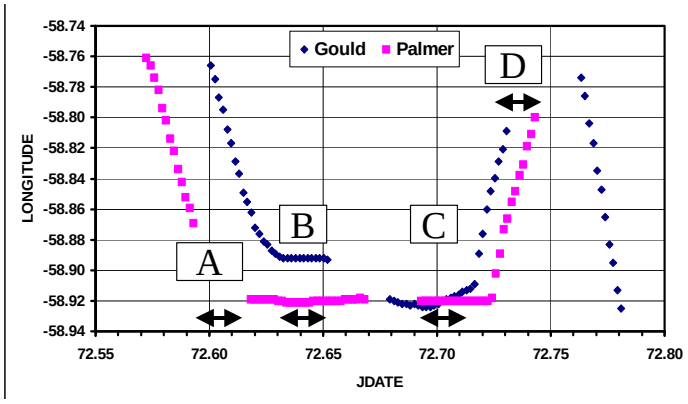
An encounter of RVIB Palmer with RV Gould in waters within the Bransfield Strait, Antarctica, near the King Georges Island, on March 13, 2009, presented an opportunity for a comparison of the LDEO underway pCO_2 systems aboard these ships. Although these ships were close to each other over the period of 4 hours, a precise comparison of the pCO_2 and SST data was hindered by high variability of waters caused by the complex current patterns, small scale eddies and fingers near the island. Our analysis shows that the surface water pCO_2 and SST values from these ships are indistinguishable within one standard deviation of 7.5 uatm and 0.07 °C respectively. The magnitude of mutual consistency could not be determined more precisely due to highly variable waters in the near shore environments.

2. OBSERVATIONS

2-a) Positions of the ships:

Fig. 1 shows the longitude of the positions as a function of time. During the time period "A", the Palmer was sailing SE and was followed by the Gould about 40 minutes behind along the same track. During the period "B", the Palmer was located about 3 km south of the Gould for about 30 minutes; and during the period "C", they were less than 300 meters apart for about 20 minutes. During the period "D", the Palmer sailed SE, followed by the Gould about 15 minutes behind along the same track. For our data analysis, we take a 15-minute section from each of the four periods.

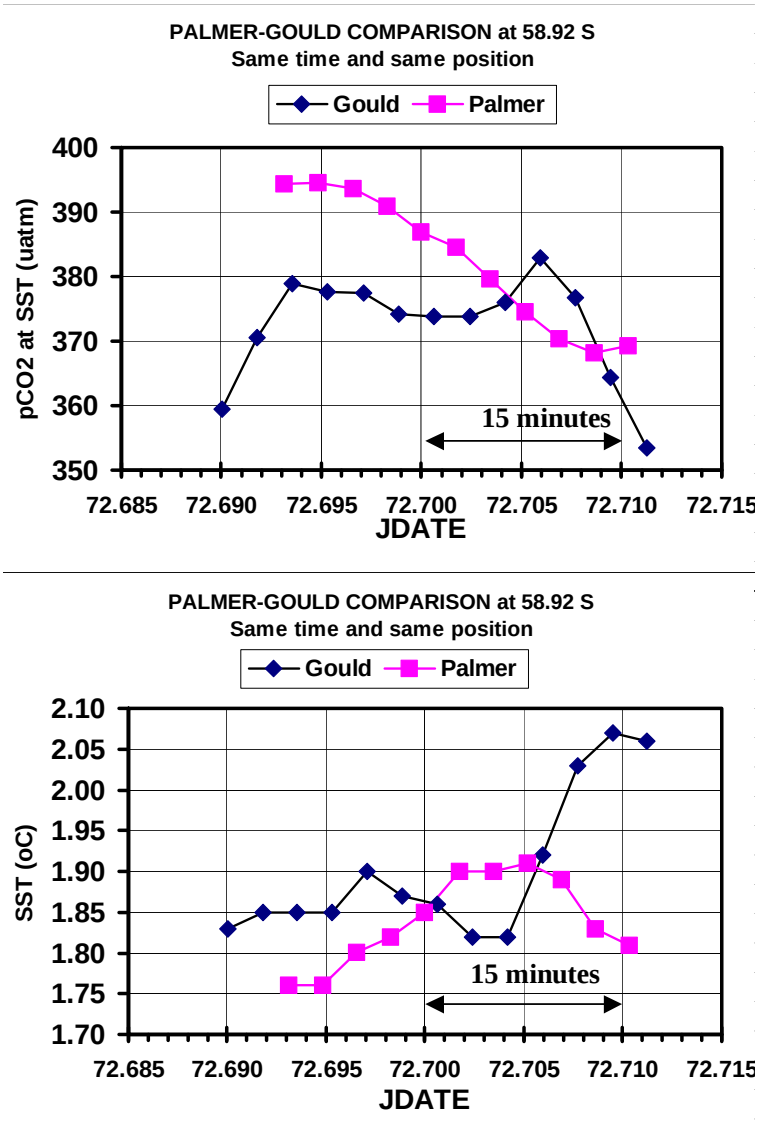
Figure 1 - Ship's positions (longitude) as a function of time. Black dots are for the Gould, and the pink dots are for the Palmer. Arrows A, B, C and D indicate the periods, during which the pCO_2 and SST data from the ships are compared. The data gaps are due to 25-minute CO_2 calibration periods. The distance between the horizontal lines (0.02 degrees) is about 2 km; the time between a pair of notches (0.01 day) is 15 minutes.



2-b) Same time, and the ships located within 300 meters (Period "C'):

The surface water pCO_2 and SST data obtained aboard the Gould and Palmer during the same time period are compared in Fig. 2. The ships were in the shadow of the western tip of King Georges Island, and were less than 300 meters during this period. Because of the highly heterogeneous environments caused by small scale eddies and turbulences near the island, the trends between the data from the two ships differ significantly. Therefore, an average difference computed over the 15 minute period indicated by the arrows is used for comparison. The mean difference (Gould – Palmer) thus estimated is –2.1 ± 8.5 uatm and +0.044 ± 0.13 °C, where ± one standard deviation is used to express the local variability. This indicates that between-ship difference cannot be determined better than the local variability.

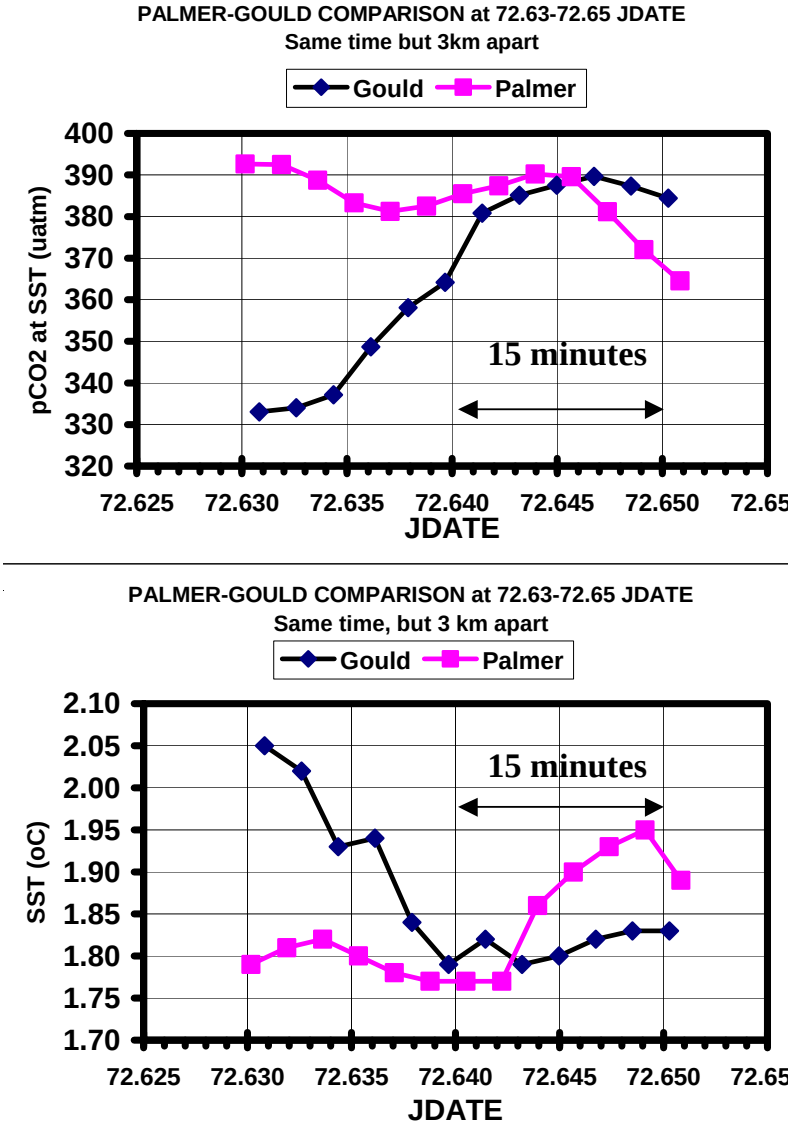
Figure 2 – Surface water pCO_2 and SST data obtained aboard the Gould and Palmer at the same time when the ships were less than 300 meters apart.



2-c) Same time, and ships located 3 km apart (Period "B):

During a period of 15 minutes (Period B in Fig. 1), the ships were 3 km apart, and the data are compared in Fig. 3. The mean differences between the data from the ships (Gould – Palmer) are computed for the 15 minute period indicated by the arrow, yielding +0.5 ± 10.3 uatm and –0.054 ± 0.063 °C. Although the measurements from the two ships are statistically indistinguishable, the magnitude of agreement cannot be assessed better than ±10 uatm and ±0.06 °C due to local oceanographic variability.

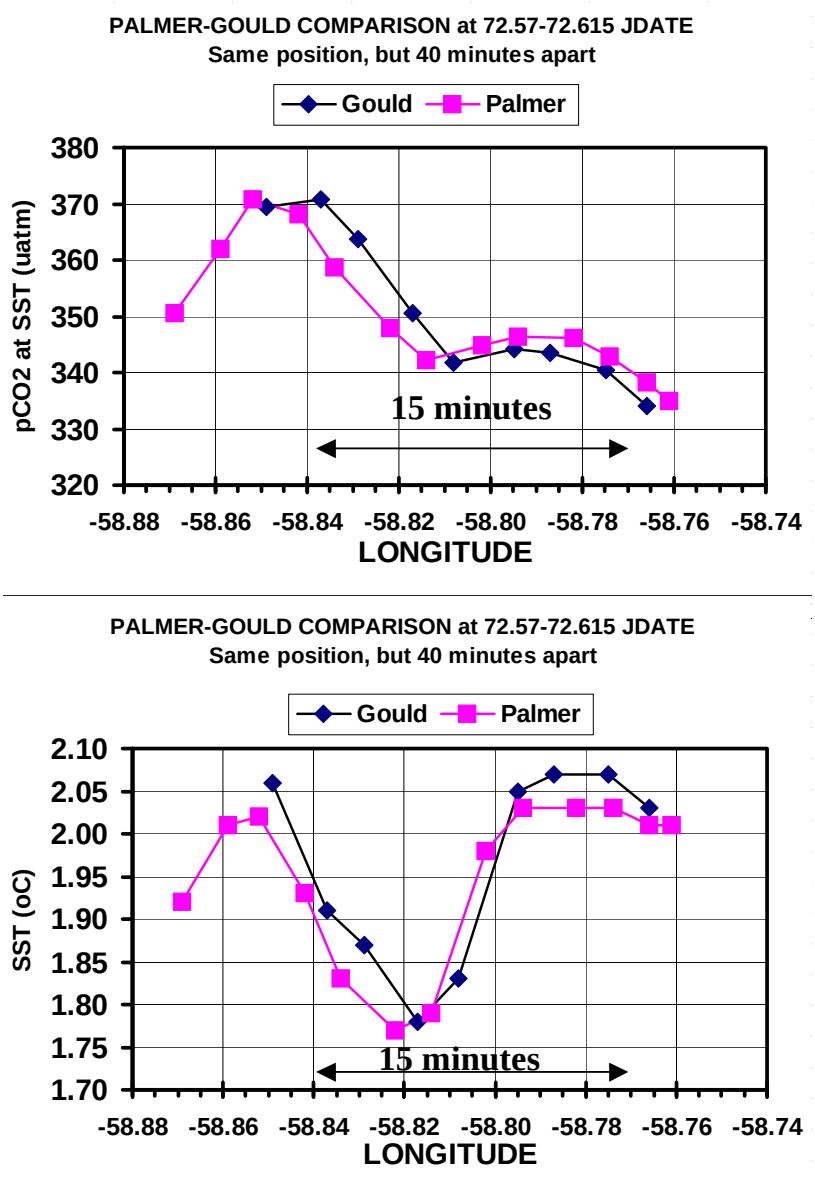
Figure 3 – Surface water pCO_2 and SST data obtained aboard the Gould and Palmer at the same time. The ships were 3 kilometers apart during the 15 minute period indicated by the arrow.



2-d) Ships on the same track, but the Gould 40 minutes behind (Period "A"):

The ships sailed along the same track, but the Gould was about 40 minutes behind the Palmer (Period A in Fig. 1). The data are compared in Fig. 4. The mean differences between the data from the ships (Gould – Palmer), which are computed for the 15 minute period (indicated by the arrow in Fig. 4) over a distance of 5.9 km, are +1.2 ± 5.0 uatm and +0.024 ± 0.034 °C. Although the measurements from the two ships are statistically indistinguishable, the magnitude of agreement cannot be assessed better than ±5 uatm and ±0.03 °C due to local oceanographic variability.

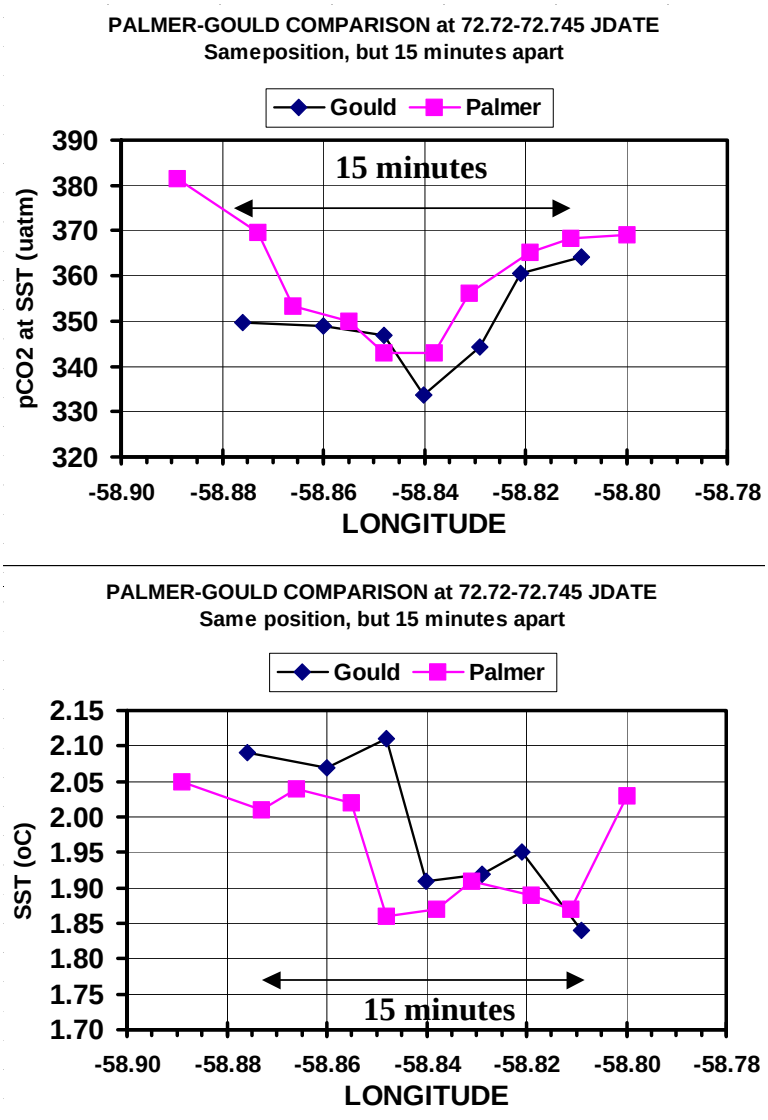
Figure 4 – Surface water pCO_2 and SST data obtained aboard the Gould and Palmer as the ships sailed along the same track (Period A in Fig. 1). The Gould was trailing the Palmer by about 40 minutes. The arrow shows the period of 15 minutes, during which the data are compared.



2-e) Ships on the same track, but the Gould 15 minutes ahead (Period "D"):

The ships sailed along the same track, but the Palmer was about 15 minutes behind the Gould (Period D in Fig. 1). The data are compared in Fig. 5. The mean differences between the data from the ships (Gould – Palmer), which are computed for the 15 minute period (indicated by the arrow in Fig. 5) over a distance of 6.2 km, are -0.7 ± 6.1 uatm and +0.059 ± 0.061 °C. Although the measurements from the two ships are statistically indistinguishable, the magnitude of agreement cannot be assessed better than ±6 uatm and ±0.06 °C due to local oceanographic variability.

Figure 5 – Surface water pCO_2 and SST data obtained aboard the Gould and Palmer as the ships sailed along the same track (Period D in Fig. 1). The Palmer was trailing the Gould by about 15 minutes. The arrow shows the period of 15 minutes, during which the data are compared.



3. SUMMARY AND RECOMMENDATION

For a duration of about 4 hours on March 13, 2009, RVIB Palmer sailed near RV Gould in waters within the Bransfield Strait, Antarctica, near the King Georges Island. This presented an opportunity to test the compatibility of the LDEO underway pCO_2 systems aboard each of these ships. Although these ships were close to each other in time and space, a precise comparison of the pCO_2 and SST data was hindered by high variability of waters near the island. The results of our analysis are summarized in Table 1 below. It shows that the surface water pCO_2 and SST values from these ships are indistinguishable within ± 7.5 uatm and ± 0.07 °C respectively. The magnitude of disagreement could not be determined more precisely due to highly variable waters in the near shore environments.

In order to further test the compatibility of the two underway pCO_2 systems more precisely, an oceanographically homogeneous environment is desirable. Another opportunity in such an environment is recommended for performing a critical test.

Table 1 – Summary of comparison of the surface water pCO_2 and SST data obtained by the LDEO underway pCO_2 systems aboard the Palmer and the Gould during an encounter near the King Georges Island, Bransfield Strait, Antarctica on March 12, 2009.

	MEAN DIFFERENCE (Gould - Palmer)			
	pCO2 (uatm)		SST (°C)	
	MEAN	STDEV	MEAN	STDEV
Same Position & same time (15 minutes, < 300 m apart)	-2.1	8.5	0.044	0.125
Same position, but 3 km apart over 15 minutes period	0.5	10.3	-0.054	0.063
Same position over 6.2 km distance, but 15 minutes apart	-0.7	6.1	0.059	0.061
Same position over 5.9 km distance, but 40 minutes apart	1.2	5.0	0.024	0.034
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MEAN	-0.3	7.5	0.018	0.071

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